

[Primary Care]



Protracted Recovery From a Concussion: A Focus on Gender and Treatment Interventions in an Adolescent Population

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Background: Several studies have demonstrated that age and sex may influence concussion recovery time frames, with female athletes and adolescents being potentially more susceptible to a protracted recovery course. Currently, limited work has examined the influence sex may have on concussion management strategies and treatment interventions, especially for younger individuals suffering persistent concussion symptoms and cognitive dysfunctions.

Hypothesis: Female athletes are prescribed more treatment interventions than male athletes during a protracted recovery from a concussion.

Study Design: Descriptive epidemiology study.

Level of Evidence: Level 4.

Methods: Data were retrospectively collected for adolescent athletes presenting to a sports medicine concussion clinic between September 2010 and September 2011.

Results: A total of 266 adolescent athletes were evaluated and treated for concussion. Female athletes had a longer recovery course ($P = 0.002$) and required more treatment interventions ($P < 0.001$) for their symptoms and dysfunction. Female athletes were more likely to require academic accommodations ($P < 0.001$), vestibular therapy ($P < 0.001$), or medication ($P < 0.001$).

Conclusion: Medical providers should be aware that during the recovery course, adolescent female athletes may require a management plan that will most likely include additional treatment interventions beyond the standard cognitive and physical rest.

Clinical Relevance: Treatment interventions are more commonly prescribed for adolescent female athletes than for adolescent male athletes during a protracted recovery from a concussion. This highlights the need for identifying evidence-based clinical management guidelines that focus on sex, especially when dealing with persistent concussion symptoms and cognitive dysfunctions.

Keywords: concussion; sex; adolescent; treatment intervention

Sex differences among concussed athletes are well documented.^{5,7,9,15,40} Dissimilarities between male and female athletes range from anthropometric, neuromuscular, and strength differences to postconcussion symptoms and cognitive dysfunctions that can influence an individual's recovery time. Over the past decade, epidemiologic studies have identified a surge in the incidence of sport-related

concussions for female athletes²⁶ as well as an increased rate of injury for female athletes when compared with male athletes in sex-equivalent sports.^{15,26,28,37} Female athletes have longer cervical spine segments and may not be as efficient at transmitting impact forces from their head into their torso via their cervical musculature during a concussive event, thus potentially resulting in a higher incidence of injury.^{4,14,42} Female

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athletes may also be more likely to seek medical treatment for concussive symptoms and to honestly report symptoms when they suffer a concussion.^{5,7,9,10} Ultimately, sex differences in injury susceptibility and recovery time frames are most likely multifactorial in etiology and reinforce the need for an individualized management approach.^{6,8}

With several million concussions occurring each year in the United States, paired with a heightened public recognition of appropriate and prompt care for this injury acutely, clinicians are seeing an increase in concussion patients.³ Current clinical guidelines advocate for individualized care by recommending physical as well as cognitive rest until resolution of postconcussion symptoms and cognitive dysfunctions before reinstating exertional activities.^{32,33} In the majority of individuals, this recovery takes only a few days³² and requires few management strategies.

However, there is emerging evidence that recognizes younger individuals may experience a longer recovery course.^{19,24,31} Recent studies have estimated that adolescents may be more susceptible to a protracted recovery that requires multiple weeks or even months for the concussion to fully resolve.^{29,37} In situations where cognitive difficulties, persistent symptoms, disrupted sleeping patterns, and emotional stressors are of concern, a combination of treatment strategies may be incorporated into the management plan. Current guidelines and consensus statements provide limited direction for managing patients with persistent symptoms and dysfunctions after a concussion⁶ since a comprehensive understanding of the long-term sequelae of a concussion, especially in an adolescent population, is still largely unknown. Although it is understood that attributable variables, such as age and sex, may predispose an individual to a longer recovery course,^{5,13,23} how these variables influence the association between treatment interventions and recovery length has not been established. Therefore, the purpose of this study was to describe the frequency of treatment interventions prescribed for each sex during the management of adolescent athletes with protracted postconcussion symptoms and cognitive dysfunctions. It was hypothesized that adolescent female athletes would be prescribed more treatment interventions than male athletes during their recovery from concussion.

METHODS

A retrospective chart review design was used in this study and approved by the institutional review board. All patients were seen at an outpatient adolescent sports medicine concussion clinic, which included 2 physicians, and 1 physician assistant. Inclusion criteria were (1) initially seen between September 2010 and September 2011, (2) diagnosed with a concussion (ICD-9 code 850.9), (3) between the ages of 11 and 18 years, and (4) managed through completion of care. A large portion of our patients were treated through a community-wide comanagement program, where community pediatricians would refer patients to our clinic who were still symptomatic 3 weeks after injury.

Recovery from the concussion was determined by the medical provider once the individual and their parent or guardian expressed their symptoms were back to baseline. Signs of recovery included behaving normally at home, completing full academic activities with no restrictions or limitations, demonstrating competent scores on neurocognitive tests, and clearance for unrestricted physical activity.

The primary outcomes for this study were sex and the number of treatment interventions during the management of a concussion for adolescent athletes. Treatment interventions included rest, academic accommodations, and medications as well as referrals to physical therapy, vestibular therapy, neuropsychology, neurology, speech pathology, and psychology. During the rest period, patients were asked to avoid the classroom environment and to refrain from participation in academic activities at home. The interventions of rest and academic accommodations were identified by school notes.

Statistical analyses were conducted using SAS (version 9.3; SAS Institute). Descriptive analysis was conducted for age, sport, and treatment interventions. A single-factor analysis of variance was used to determine the differences between sex and recovery along with sex and number of prescribed treatment interventions. A univariate logistic regression with an alpha level set at 0.05 was used to determine sex and specific treatment intervention.

RESULTS

A total of 266 adolescent athletes, including 102 female athletes, who were treated for concussion during the 2010-2011 sports season met the inclusion criteria for this study (Figure 1). The average ages for female and male athletes were 14.9 ± 3.4 years and 14.3 ± 2.3 years, respectively. On average, female athletes took longer to recover from their concussions than male athletes: 75.6 ± 73.0 and 49.7 ± 62.0 days, respectively ($P = 0.002$). More than half the female (67.6%) and male (53%) athletes had a recovery time greater than 1 month (Figure 2).

The most commonly prescribed treatment interventions for female and male athletes were rest (95.1% and 73.2%) and academic accommodations (72.5 and 42.1%), respectively. The average number of treatment interventions prescribed during the management of a concussion was 2.2 ± 1.5 for female and 1.3 ± 1.0 for male athletes ($P < 0.001$). The differences in treatment interventions between sexes were significant for rest ($P < 0.001$), academic accommodations ($P < 0.001$), vestibular therapy ($P < 0.001$), and medications ($P < 0.001$). Female athletes were 7 times more likely to be prescribed rest, 3 times more likely to be prescribed academic accommodations, 8 times more likely to be prescribed vestibular therapy, and 4 times more likely to be prescribed medication over male athletes (Table 1).

DISCUSSION

To enhance the understanding of the complex interaction between sex and age on concussion recovery, this study aimed to investigate the frequency of treatment interventions

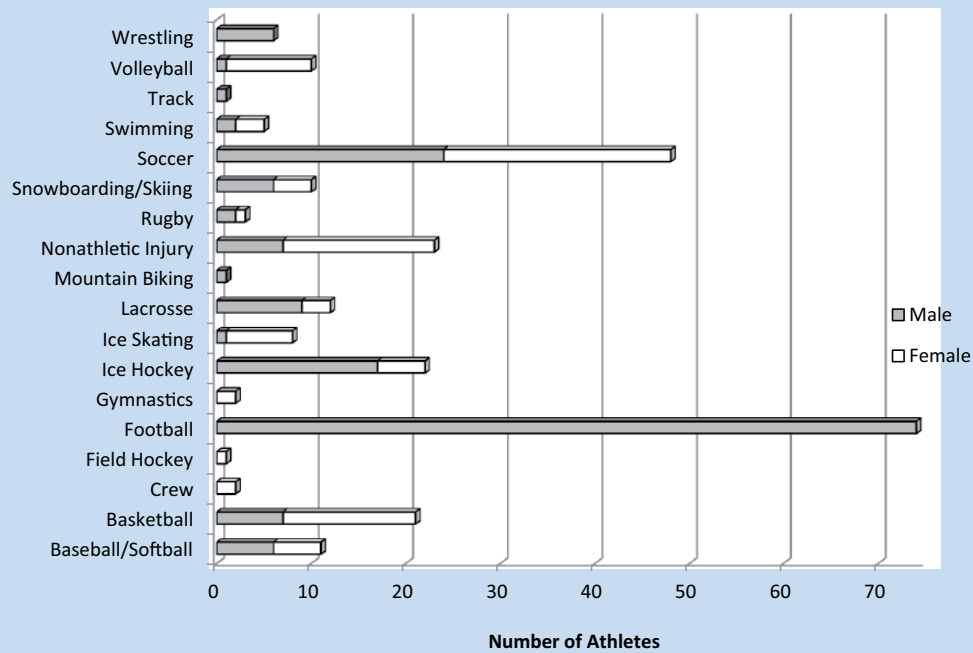


Figure 1. Sports participation at the time of concussion.

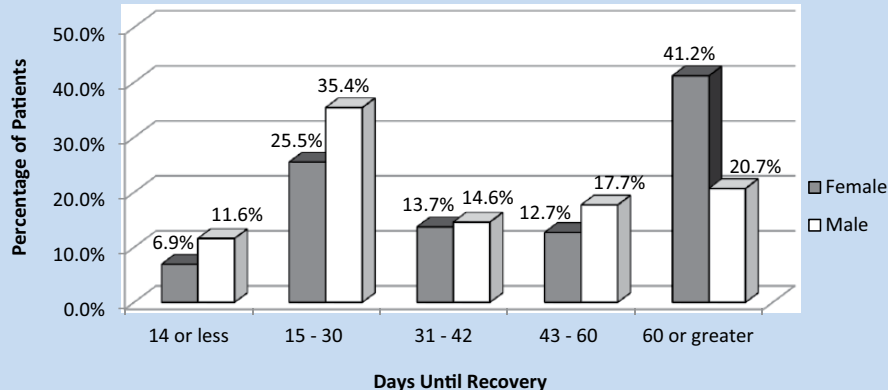


Figure 2. Time until recovery for each sex.

prescribed for each sex during the management of adolescent athletes with a protracted recovery from a concussion.

The results of this study extend the understanding of persistent concussion symptoms and current management strategies in several ways. First, these results support current evidence that adolescent athletes require a greater amount of time to recover from a concussion than the traditionally quoted time frame of 7 to 10 days. The results also showed that adolescent female athletes were more likely to require additional treatment interventions beyond the standard cognitive and physical rest.

This emphasizes the need for an individualized management plan for an athlete recovering from a concussion.

Physical and cognitive rest is the cornerstone of concussion management.³³ Those suffering from a concussion are recommended to rest from activities that exacerbate concussive symptoms. In our cohort, nearly all female athletes and the majority of male athletes were prescribed a period of rest after their concussions. Although rest was the most commonly prescribed treatment for each sex, a difference was found in the number of female athletes prescribed a period of absolute rest

Table 1. Number of patients who were prescribed each treatment intervention during the management of their concussion

Intervention/Referral	Male Patients (N = 164)	Female Patients (N = 102)	Odds	CI	P
Rest	120	97	7.11	2.71-18.6	<0.001
Academic accommodations	69	74	3.63	2.13-6.21	<0.001
Vestibular therapy	9	33	8.23	3.7-18.1	<0.001
Medications	10	22	4.23	1.91-9.37	<0.001
Physical therapy	5	8	2.70	0.86-8.51	0.080
Neuropsychology	3	10	5.83	1.56-21.7	0.009
Neurology	0	6	—	—	0.984
Speech pathology	2	2	1.62	0.23-11.68	0.632
Psychology	0	1	—	—	0.986

from academic and physical activities compared with male athletes. Female athletes often report a greater number of symptoms after a concussion and have greater declines in cognitive function than male athletes.⁵ Given the potential impact of these concussive symptoms and cognitive impairments on academic activities, it is possible that medical providers are more likely to initiate a period of absolute rest for female athletes as compared with male athletes.

Unfortunately, there is currently no standard length of rest an individual will require after a concussion. However, in most patients, there is a point where the clinical benefits of rest are outweighed by the side effects caused by the lack of activity and social interactions. At this stage, the treating provider should alter a patient's treatment to address the current concussive symptoms while avoiding the negative side effects that may further delay recovery.

When a student is absent for an extended period of time, there may be a certain level of stress and anxiety about integrating back into the classroom environment.³⁵ Students may become overwhelmed with trying to balance the normal workload of their classes with the additional task of completing the missed assignments during their absence. Approximately 6.3% of healthy adolescents have positive generalized anxiety disorder screens¹¹ and may experience subclinical anxiety concerns over academics, social acceptance, and emotional difficulties,^{16,17,34} with many of these symptoms beginning as early as age 11 years.²¹ A disproportionate number of healthy adolescent female athletes, as compared with healthy adolescent male athletes, commonly express concerns about trouble sleeping, feeling tired, and being stressed out¹¹ among other anxiety symptoms.¹⁶

This study showed that female athletes with concussions were 3 times more likely than male athletes to be prescribed academic accommodations for their transition back into the classroom after a period of absolute rest. Therefore, it appears that female athletes

may be more likely to need the security of academic accommodations to help ease potential anxiety or stress over missed assignments and incomplete grades. Although the exact accommodations prescribed were not collected as part of this study, they commonly range from simple adaptations such as assignment deadline extensions to aggressive modifications of the academic environment such as accommodations for light and noise sensitivity. In certain situations, the use of a tutor or implementation of a temporary action strategy that addresses the student's current cognitive disabilities¹⁸ (504 plan) may be required in the event of a prolonged absence from the classroom.³⁵

Vestibular and visual dysfunctions have been identified in concussed individuals^{1,2} with persistent symptoms of dizziness, imbalance, headaches, and nausea commonly provoked by repetitive eye movements during reading activities, note taking, or riding in a car. Although dizziness is a commonly reported symptom in the acute phase of a concussion,^{15,28} dizziness during the on-field assessment of a concussion is an identifier of a protracted recovery course.²⁵

Vestibular therapy has been implemented in patients with chronic symptoms during activities of daily living after head injuries.^{1,2,20} In this study,¹ female athletes were 8 times more likely to be prescribed vestibular therapy. Therefore, female athletes may be more susceptible than male athletes to vestibular or visual dysfunctions during their concussive episodes. These results may be limited by the lack of consideration of severity of postconcussion symptoms, which may have influenced the medical provider's decision to prescribe such treatments. Unfortunately, little is known about the relationship of vestibular and visual dysfunctions to concussions as well as the appropriate time during the recovery course to implement therapeutic exercises. Cervical strains and whiplash injuries can present with similar symptoms of headache, dizziness, nausea, and visual dysfunction.^{12,38}


To date, there has been no evidence to support medication usage to help correct the pathophysiologic processes that occur from trauma-induced biomechanical forces and thus shorten recovery times for a concussion.³⁰ Since there is a limited role of over-the-counter medications for management of cognitive or somatic symptoms, medications are typically used to control significant or persistent symptoms. Melatonin may be a useful over-the-counter medication for sleep initiation in conjunction with sleep hygiene counseling.³⁶ The off-label benefits of some prescription medications are options for managing somatic and cognitive symptoms^{22,41} as well as sleep alternations.³⁹ These medications should only be considered for those with prolonged recovery and functional deficits due to specific symptoms,⁴¹ as medications may preclude a return to physical activity. The concussed individual should be symptom free prior to progressing through a graded return to physical activity.³²

This study has several limitations, including the interpretation of clinical notes, missing charts, unrecorded information, and incomplete documentation. In addition, clinical outcomes were not used during the management of this injury to determine the

effectiveness of each prescribed treatment intervention. It is possible that individually prescribed interventions did not improve the individual's symptoms or dysfunctions and therefore additional interventions were applied to the management plan. Last, although statistically significant differences were found between sex and recovery as well as sex and treatment intervention, this study did not evaluate injury severity. It is possible that female athletes had more severe concussions than male athletes, which could explain the additional treatment interventions prescribed during the management of their injury.

CONCLUSION

Adolescent athletes may be susceptible to a protracted recovery course from a concussion. Persistent symptoms and chronic cognitive dysfunctions can impact an adolescent athlete recovering from a concussion. Young female athletes may require an individualized treatment plan that will most likely contain additional treatment interventions outside of the standard cognitive and physical rest.



Clinical Recommendations

SORT: Strength of Recommendation Taxonomy

A: consistent, good-quality patient-oriented evidence
B: inconsistent or limited-quality patient-oriented evidence
C: consensus, disease-oriented evidence, usual practice, expert opinion, or case series

Clinical Recommendation	SORT Evidence Rating
Adolescent athletes may be susceptible to a protracted recovery course after a concussion. ^{27,37}	C
Sex differences may exist when prescribing treatment interventions for adolescent athletes with persistent concussion symptoms and cognitive dysfunctions. ⁸	C

REFERENCES

1. Alsalaheen BA, Mucha A, Morris LO, et al. Vestibular rehabilitation for dizziness and balance disorders after concussion. *J Neurol Phys Ther.* 2010;34:87-93.
2. Alsalaheen BA, Whitney SL, Mucha A, Morris LO, Furman JM, Sparto PJ. Exercise prescription patterns in patients treated with vestibular rehabilitation after concussion. *Physiother Res Int.* 2013;18:100-108.
3. Bakhos LL, Lockhart GR, Myers R, Linakis JG. Emergency department visits for concussion in young child athletes. *Pediatrics.* 2010;126:e550-e556.
4. Barth JT, Freeman JR, Broshek DK, Varney RN. Acceleration-deceleration sport-related concussion: the gravity of it all. *J Athl Train.* 2001;36:253-256.
5. Broshek DK, Kaushik T, Freeman JR, Erlanger D, Webb F, Barth JT. Sex differences in outcome following sports-related concussion. *J Neurosurg.* 2005;102:856-863.
6. Broshek DK, Samples H, Beard J, Goodkin HP. Current practices of the child neurologist in managing sports concussion. *J Child Neurol.* 2014;29:17-22.
7. Colvin AC, Mullen J, Lovell MR, West RV, Collins MW, Groh M. The role of concussion history and gender in recovery from soccer-related concussion. *Am J Sports Med.* 2009;37:1699-1704.
8. Covassin T, Elbin RJ. The female athlete: the role of gender in the assessment and management of sport-related concussion. *Clin Sports Med.* 2011;30:125-131.
9. Covassin T, Schatz P, Swanik CB. Sex differences in neuropsychological function and post-concussion symptoms of concussed collegiate athletes. *Neurosurgery.* 2007;61:345-350.
10. Dick RW. Is there a gender difference in concussion incidence and outcomes? *Br J Sports Med.* 2009;43(suppl 1):i46-i50.
11. Dumont IP, Olson AL. Primary care, depression, and anxiety: exploring somatic and emotional predictors of mental health status in adolescents. *J Am Board Fam Med.* 2012;25:291-299.
12. Fernandez-de-Las-Penas C, Simons D, Cuadrado ML, Pareja J. The role of myofascial trigger points in musculoskeletal pain syndromes of the head and neck. *Curr Pain Headache Rep.* 2007;11:365-372.
13. Field M, Collins MW, Lovell MR, Maroon J. Does age play a role in recovery from sports-related concussion? A comparison of high school and collegiate athletes. *J Pediatr.* 2003;142:546-553.
14. Garces GL, Medina D, Milutinovic L, Garavate P, Guerado E. Normative database of isometric cervical strength in a healthy population. *Med Sci Sports Exerc.* 2002;34:464-470.
15. Gessel LM, Fields SK, Collins CL, Dick RW, Comstock RD. Concussions among United States high school and collegiate athletes. *J Athl Train.* 2007;42:495-503.
16. Grills-Tauchel AE, Norton P, Ollendick TH. A longitudinal examination of factors predicting anxiety during the transition to middle school. *Anxiety Stress Coping.* 2010;23:493-513.

17. Grills AE, Ollendick TH. Peer victimization, global self-worth, and anxiety in middle school children. *J Clin Child Adolesc Psychol.* 2002;31:59-68.
18. Halstead ME, McAvoy K, Devore CD, Carl R, Lee M, Logan K. Returning to learning following a concussion. *Pediatrics.* 2013;132:948-957.
19. Halstead ME, Walter KD. American Academy of Pediatrics. Clinical report—sport-related concussion in children and adolescents. *Pediatrics.* 2010;126:597-615.
20. Hoffer ME, Gottshall KR, Moore R, Balough BJ, Wester D. Characterizing and treating dizziness after mild head trauma. *Otol Neurotol.* 2004;25:135-138.
21. Kessler RC, Berglund P, Demler O, Jin R, Merikangas KR, Walters EE. Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Arch Gen Psychiatry.* 2005;62:593-602.
22. Kinnaman KA, Mannix RC, Comstock RD, Meehan WP 3rd. Management strategies and medication use for treating paediatric patients with concussions. *Acta Paediatr.* 2013;102:e424-e428.
23. Kontos AP, Covassin T, Elbin RJ, Parker T. Depression and neurocognitive performance after concussion among male and female high school and collegiate athletes. *Arch Phys Med Rehabil.* 2012;93:1751-1756.
24. Kutcher JS, Eckner JT. At-risk populations in sports-related concussion. *Curr Sports Med Rep.* 2010;9:16-20.
25. Lau BC, Kontos AP, Collins MW, Mucha A, Lovell MR. Which on-field signs/symptoms predict protracted recovery from sport-related concussion among high school football players? *Am J Sports Med.* 2011;39:2311-2318.
26. Lincoln AE, Caswell SV, Almquist JL, Dunn RE, Norris JB, Hinton RY. Trends in concussion incidence in high school sports: a prospective 11-year study. *Am J Sports Med.* 2011;39:958-963.
27. Lovell MR, Collins MW, Iverson GL, et al. Recovery from mild concussion in high school athletes. *J Neurosurg.* 2003;98:296-301.
28. Marar M, McIlvain NM, Fields SK, Comstock RD. Epidemiology of concussions among United States high school athletes in 20 sports. *Am J Sports Med.* 2012;40:747-755.
29. McClincy MP, Lovell MR, Pardini J, Collins MW, Spore MK. Recovery from sports concussion in high school and collegiate athletes. *Brain Inj.* 2006;20:33-39.
30. McCrory P. Should we treat concussion pharmacologically? The need for evidence based pharmacological treatment for the concussed athlete. *Br J Sports Med.* 2002;36:3-5.
31. McCrory P, Johnston K, Meeuwisse W, et al; International Symposium on Concussion in Sport. Summary and agreement statement of the 2nd International Conference on Concussion in Sport, Prague 2004. *Clin J Sport Med.* 2005;15:48-55.
32. McCrory P, Meeuwisse W, Aubry M, et al. Consensus statement on Concussion in Sport—the 4th International Conference on Concussion in Sport Held in Zurich, November 2012. *Clin J Sport Med.* 2013;23:89-117.
33. McCrory P, Meeuwisse W, Johnston K, et al. Consensus Statement on Concussion in Sport: the 3rd International Conference on Concussion in Sport held in Zurich, November 2008. *J Athl Train.* 2009;44:434-448.
34. McGee R, Feehan M, Williams S, Anderson J. DSM-III disorders from age 11 to age 15 years. *J Am Acad Child Adolesc Psychiatry.* 1992;31:50-59.
35. McGrath N. Supporting the student-athlete's return to the classroom after a sport-related concussion. *J Athl Train.* 2010;45:492-498.
36. Meehan WP 3rd. Medical therapies for concussion. *Clin Sports Med.* 2011;30:115-124.
37. Meehan WP 3rd, d'Hemecourt P, Comstock RD. High school concussions in the 2008-2009 academic year: mechanism, symptoms, and management. *Am J Sports Med.* 2010;38:2405-2409.
38. Missaghi B. Sternocleidomastoid syndrome: a case study. *J Can Chiropr Assoc.* 2004;48:201-205.
39. Morin AK, Jarvis CI, Lynch AM. Therapeutic options for sleep-maintenance and sleep-onset insomnia. *Pharmacotherapy.* 2007;27:89-110.
40. Preiss-Farzanegan SJ, Chapman B, Wong TM, Wu J, Bazarian JJ. The relationship between gender and postconcussion symptoms after sport-related mild traumatic brain injury. *PM R.* 2009;1:245-253.
41. Reddy CC, Collins M, Lovell M, Kontos AP. Efficacy of amantadine treatment on symptoms and neurocognitive performance among adolescents following sports-related concussion. *J Head Trauma Rehabil.* 2013;28:260-265.
42. Tierney RT, Sitler MR, Swanik CB, Swanik KA, Higgins M, Torg J. Gender differences in head-neck segment dynamic stabilization during head acceleration. *Med Sci Sports Exerc.* 2005;37:272-279.

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